Impact of frontline demonstrations on different vegetables grown in Samba district of Jammu and Kashmir

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ABSTRACT

This study evaluated the impact of frontline demonstrations (FLDs) conducted by Krishi Vigyan Kendra (KVK), Samba, Jammu and Kashmir across 120 locations covering 8.5 hectares in the Samba district of Jammu and Kashmir during 2023-24 and 2024-25. The trials assessed high-yielding vegetable varieties: knol-khol (G-40), okra (Jammu Okra-05), onion (Bhima Red), spinach (Jammu Spinach Beet-07) and radish (Pusa Chetki), against traditional local practices under irrigated farming conditions. Results revealed significant productivity gains, with yield increases over local checks ranging from 22.0 per cent in radish to 53.4 per cent in okra. Okra achieved the highest percentage yield increase (136.0 vs 88.6 q/ha in check) due to its superior tolerance to biotic and abiotic stresses. Realization of potential yield (technology realization) was highest in okra (90.7%) and knol-khol (90.0%), while onion and spinach exhibited unexploited yield gaps of roughly 18.0-19.0 per cent. The technology index varied between 9.3 per cent (okra) and 19.2 per cent (spinach), confirming high feasibility and adaptability of the demonstrated varieties across local agro-ecological conditions. Extension gaps ranged from 21.0 q per ha (spinach) to 55.0 q per ha (onion), emphasizing a wide lag between recommended management practices and traditional farming methods. Economic evaluation demonstrated substantial profitability enhancements without increasing operational costs, as cultivation expenditures remained identical across both regimes (Rs 70,000/ha to Rs 84,000/ha). Knol-khol recorded the highest net return (Rs 2,97,000/ha) and benefit-cost (B:C) ratio (3.8), whereas, radish achieved the highest incremental net return over traditional practices (Rs 1,14,000/ha). The findings establish that integrating improved cultivars with scientific management via FLDs significantly enhances farm income and bridges field-level productivity gaps in the region.

Keywords: Benefit-cost ratio, Extension gap, Frontline demonstrations, High-yielding varieties, Technology index, Vegetable productivity

INTRODUCTION

Vegetable production in the Samba district of Jammu and Kashmir contributes a significant share to the region's total vegetable yield. However, overall productivity remains low compared to other districts across the state, despite farmers cultivating a wide array of crops including knol-khol, peas, beans, tomato, brinjal, chilli, cauliflower, cabbage, onion and okra (Gupta et al 2022).

A major constraint limiting productivity and profitability is the non-availability of improved, high-yielding crop varieties (Sahu et al 2009). Currently, most growers rely on private company hybrids whose yield performance is insufficient to substantially improve farmers' economic standing. Furthermore, good-quality hybrid seeds are often only accessible at the block or village level at prohibitive costs, making them unaffordable for resource-poor farmers.

These seed-related issues compound a broader set of systemic challenges. In Samba district, marginal and small-holder vegetable farmers face critical constraints including a lack of awareness, adherence to traditional norms, irregular extension worker visits, low extension worker credibility, delayed input access and an absence of timely technical advice. Additionally, technological hurdles persist, such as inadequate training programmes, poor approach to field demonstrations,

missing location-specific recommendations, a lack of follow-up services and an absence of proper post-harvest technologies (Gupta et al 2022).

To address these gaps, Krishi Vigyan Kendras (KVKs) serve as key district-level knowledge resource hubs that help modernize Indian agriculture beyond subsistence farming (Kushwaha et al 2026, Mukherjee et al 2024, Saidulu 2025). Operating on the principle of 'seeing is believing,' KVKs utilize frontline demonstrations (FLDs) to upgrade skills, provide scientific information and showcase newly released varieties under actual farming conditions (Antil et al 2025, Ghosh et al 2024, Ola et al 203). Demonstrating improved practices directly on farmers' fields plays a pivotal role in raising awareness and accelerating the adoption of new agricultural technologies.

To solve the productivity bottleneck directly, KVK, Samba, Jammu and Kashmir conducted field demonstrations across irrigated farms during 2023-24 and 2024-25. By introducing high-yielding vegetable varieties specifically bred to resist environmental stress, pests and diseases, the initiative directly compared performance against traditional local crops to demonstrate clear advantages to farmers while gathering vital research data for future cultivation strategies.

MATERIAL and METHODS

During 2023-24 and 2024-25, FLDs were conducted in Samba district, Jammu and Kashmir to evaluate improved vegetable crop technologies. Prior to setting up the trials, a field survey was carried out in the adopted villages of Durie and Rajpura to select innovative vegetable farmers for participation.

The demonstrations tested five key vegetable crops using high-yielding varieties alongside local checks: Okra (Jammu Okra-05), Knol-khol (G-40), Onion (Bhima-Red), Spinach (Jammu Spinach Beet-07) and Radish (Pusa Chetki). KVK, Samba supplied critical inputs to the participating farmers, including foundation seeds, seed treatment fungicides, herbicides and insecticides.

The trials were carried out under the continuous supervision of KVK scientists, who tracked yield parameters for both the demonstrated technology and traditional farmers' practices. Regular scientist visits helped motivate farmers to adopt proper techniques while providing a way to collect qualitative feedback to refine future research and extension programmes.

To spread awareness across the wider farming community, KVK, Samba organized supplementary activities such as Kisan Goshthis, seed treatment campaigns and field days. Finally, data gathered from FLD fields and local check plots were evaluated using appropriate statistical tools to analyze yield performance differences.

Formula for the calculation of indices is given as under:

$$\text{Technology index (\%)} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100$$

Primary data were collected from the selected vegetable farmers with the help of interview schedule and presented in terms of percentage and qualitative data was converted into quantitative form and expressed in terms of per cent and increase in yield was calculated by using the formula.

RESULTS and DISCUSSION

Evaluation of high-yielding vegetable varieties and yield advantage through frontline demonstrations (FLDs)

The FLDs evaluated the yield performance, adaptability and economic superiority of high-yielding vegetable varieties compared to traditional farmer practices (local checks) across a total of 120 demonstrations covering 8.5 hectares (Table 1).

Demonstration coverage and scope: Knol-khol (var G-40) and okra (var Jammu Okra-05) received the largest coverage, with 30 demonstrations each over 3.0 ha and 2.5 ha respectively. Onion (var Bhima Red), spinach (var Jammu Spinach Beet-07) and radish (var Pusa Chetki) were demonstrated across 20 locations each, covering 1.0 ha per crop.

Yield realization and yield advantage over local check: Okra (Jammu Okra-05) recorded the highest yield increase over the check at 53.4 per cent (136.0 q/ha in FLD vs 88.6 q/ha in check). This indicated strong tolerance to prevalent local biotic/abiotic stresses (such as yellow vein mosaic virus) and superior genetic potential. Onion (Bhima Red) demonstrated a substantial 29.0 per cent yield increase (244.0 q/ha vs

Table 1. Yield performance and yield increase of improved vegetable varieties in frontline demonstrations (FLDs) compared to local checks

Crop	Variety	Number of demonstrations	Area (ha)	Yield (q/ha)			Per cent increase in yield over check
				Potential yield	Yield in FLDs	Yield in check	
Knol-khol	G-40	30	3.0	250.0	225.0	180.0	25.5
Okra	Jammu Okra-05	30	2.5	150.0	136.0	88.6	53.4
Onion	Bhima Red	20	1.0	300.0	244.0	189.0	29.0
spinach	Jammu Spinach Beet-07	20	1.0	140.0	113.0	92.0	22.8
Radish	Pusa Chetki	20	1.0	250.0	220.0	180.0	22.0

189 q/ha), highlighting better bulb development and uniform maturity under improved management. Knol-khol (G-40) achieved a 25.5 per cent increase (225.0 q/ha vs 180.0 q/ha in local check White Vienna). Spinach (Jammu Spinach Beet-07) and radish (Pusa Chetki) showed consistent improvements with 22.8 and 22.0 per cent increases, yielding 113.0 and 220.0 q per ha compared to 92.0 and 180.0 q per ha in local checks respectively.

Yield realization vs potential yield (technology realization): Knol-khol (G-40) achieved 90.0 per cent of its potential yield (225.0 q/ha out of 250.0 q/ha potential), leaving a minor realization gap of only 10.0 per cent. Okra (Jammu Okra-05) reached 90.7 per cent of its potential yield (136.0 q/ha out of 150.0 q/ha potential), showing excellent yield stability under field conditions. Radish (Pusa Chetki) achieved 88.0 per cent of its potential yield (220.0 q/ha out of 250.0 q/ha). Onion (Bhima Red) and spinach (Jammu Spinach Beet-07) realized 81.3 and 80.7 per cent of their potential yields, reflecting an unexploited gap of roughly 18.0-19.0 per cent attributable to environmental variations, micro-climatic factors or crop management constraints.

The FLD intervention confirmed that adopting improved vegetable varieties combined with recommended agro-techniques significantly bridged yield gaps, delivering consistent productivity gains of 22.0 to 53.4 per cent over existing farming practices.

Kushwah et al (2016) reported that demonstrations conducted by KVK, Katihar and Nalanda on different high-yielding vegetables recorded significantly higher yields compared to farmers' practices. Among high-yielding varieties, okra, brinjal and tomato attained peak yields of 180, 540 and 430 quintals per hectare respectively, alongside maximum yield recordings in spinach (Pusa Anmol), radish (Pusa Chetki), cauliflower (Sabour Agrim) and carrot (Pusa Kesar).

Balai et al (2013) evaluated frontline demonstrations of improved technologies for brinjal, onion and okra in Dungarpur district, Rajasthan. The improved practices recorded significantly higher average yields compared to traditional local checks: 299.15 vs 209.00 quintals per hectare for brinjal (a 43.13% increase), 207.55 vs 133.85 quintals per hectare for onion (a 55.06% increase) and 121.85 vs 77.81 quintals per hectare for okra (a 56.60% increase).

Saravanakumar et al (2020) reported that cluster frontline demonstrations in Erode district, Tamil Nadu, using high-yielding variety Vamban 6 along with bio-seed treatments, integrated pest management and foliar micronutrient applications achieved an average yield of 7.79 quintals per hectare, representing a 19.85 per cent yield advantage over traditional farming practices.

Singh and Dwivedi (2020) evaluated frontline demonstrations across five vegetable crops over three consecutive years (2015-16 to 2017-18) and recorded consistently higher yields in demonstration plots compared to traditional farmer checks. Peak average yields under improved management reached 404 quintals per hectare for tomato in 2017-18 (vs 282 q/ha in check plots), 588.50 quintals per hectare for cabbage in 2017-18 (vs 486 q/ha in check plots) and 535.50 quintals per hectare for cauliflower in 2017-18 (vs a check maximum of 376 q/ha in 2016-17). Similarly,

vegetable pea achieved a peak yield of 208 quintals per hectare in 2016-17 (vs 138 q/ha in check plots during 2015-16), while onion recorded its maximum average yield of 331.50 quintals per hectare in 2017-18 (vs a check maximum of 242 q/ha in 2016-17).

Bharti et al (2024) reported that cluster FLDs of greengram conducted by Krishi Vigyan Kendra, Harda, Madhya Pradesh across 250 farmers' fields achieved demonstration yields ranging from 12.12 to 16.38 quintals per hectare, with an average of 14.95 quintals per hectare. This represented a 23.39 per cent yield enhancement over traditional farmers' practices (12.01 q/ha). The peak demonstration yield (16.38 q/ha) also surpassed the corresponding district (16.0 q/ha), state and national average productivities.

Lodhi et al (2025) in a four-year frontline demonstration in Mahasamund district, Chhattisgarh, evaluated the improved vegetable cowpea variety Kashi Kanchan. Compared to traditional farmers' practice, adopting the recommended practice increased yields by 20.7 to 38.0 per cent (peaking in 2024).

Roshan and Pebam (2025) reported that in the Churachandpur district, Manipur, FLDs of the improved cabbage variety Green Hero yielded 320 to 335 quintals per hectare, significantly outperforming traditional local farming practices, which yielded only 140 quintals per hectare. Adopting these improved management practices resulted in a yield increase ranging from 128.57 to 139.29 per cent over traditional methods.

Technology gap, extension gap and technology index analysis across demonstrated vegetable crops

The analysis of technology gap, extension gap and technology index evaluated the extent of technology adoption and the effectiveness of extension interventions across the selected vegetable crops (Table 2).

Technology gap: Onion recorded the highest technology gap (56.0 q/ha), followed by radish (30.0 q/ha), spinach (27.0 q/ha) and knol-khol (25.0 q/ha). Okra registered the lowest technology gap (14.0 q/ha). The technology gap reflected the difference between potential yield and demonstration (FLD) yield, which was primarily attributable to variations in micro-climatic conditions, soil fertility status, weather fluctuations and local biotic/abiotic stress factors across trial locations.

Extension gap: Onion exhibited the widest extension gap (55.0 q/ha), closely followed by okra (47.4 q/ha), knol-khol (45.0 q/ha) and radish (40.0 q/ha). Spinach recorded the lowest extension gap (21.0 q/ha). The substantial extension gap across most crops highlighted a significant lag between research-recommended management practices and conventional farming methods. This underscored the urgent need to educate farmers through frontline demonstrations, field days and capacity-building programmes to accelerate the adoption of high-yielding varieties and package of practices.

Technology index: Okra registered the lowest technology index (9.3%), closely followed by knol-khol (10.0%) and radish (12.0%). Lower values of the technology index indicate higher feasibility, adaptability and performance of the demonstrated technology in farmers' fields. Onion (18.6%) and spinach (19.2%) recorded higher technology indices, suggesting that while the technologies performed well, additional refinement in production technologies, such as pest management, nutrient scheduling or irrigation, could further improve yield realization under field conditions.

Overall, the findings demonstrated that while the demonstrated production technologies were highly feasible across all vegetable crops (technology indices ranging between 9.3 and 19.2%), the wide extension

Table 2. Technology and extension gaps and technology index for select vegetable crops

Crop	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
Knol-khol	25	45	10
Okra	14	47.4	9.3
Onion	56	55	18.6
Spinach	27	21	19.2
Radish	30	40	12

gaps emphasized the critical role of systematic extension efforts in bridging the productivity gap at the farm level.

Balai et al (2013), analyzing technology transfer metrics in Dungarpur district, Rajasthan, observed technology gaps of 50.85 quintals per hectare in brinjal, 42.45 quintals per hectare in onion and 28.15 quintals per hectare in okra. Extension gaps were highest in brinjal (90.15 q/ha), followed by onion (73.70 q/ha) and okra (44.04 q/ha). The technology index was lowest for brinjal (14.53%), followed by onion (16.98%) and okra (18.77%), demonstrating high feasibility of the improved package of practices under local farming conditions.

Kushwah et al (2016) found that most crop varieties and hybrids exhibited a wide extension gap, with the exception of Sabour Agrim, Pusa Kesar and Pusa Anmol. The low technology index for these specific varieties highlighted a strong adoption potential, emphasizing the urgent need for targeted farmer training and extension programmes to accelerate field-level technology transfer.

Saravanakumar et al (2020), evaluating the technology transfer parameters, recorded an extension gap of 1.29 quintals per hectare, a technology gap of 0.79 quintals per hectare and a low technology index of 8.35 per cent for black gram cultivation in Erode district, Tamil Nadu.

Bharti et al (2024), analyzing technology adoption and dissemination metrics for green gram (variety MH-421), observed a mean extension gap of 293.2 kg per hectare (2.93 q/ha). The technology gap and technology index were evaluated against the potential yield of the demonstrated variety, highlighting the scope for further narrowing field-level productivity gaps through improved management practices.

Roshan and Pebam (2025) reported that frontline demonstrations of the improved cabbage variety Green Hero yielded extension gaps ranging from 180 to 195 quintals per hectare. Over the demonstration period, technology gaps narrowed from 80 quintals per hectare in the first year to 65 quintals per hectare in the final year. Correspondingly, the technology index declined from 25.00 to 19.40 per cent, demonstrating the growing feasibility and adoption of the improved package of practices among local farmers.

Economic feasibility and profitability analysis of frontline demonstrations (FLDs)

The economic evaluation presented in Table 3 demonstrated the financial viability and profitability of FLDs compared to traditional farmer practices across all five vegetable crops.

Cost of cultivation: The expenditure incurred under FLDs was recorded as identical to traditional practices for each respective crop, ranging from Rs 70,000 per ha (okra) to Rs 84,000 per ha (onion).

Because total input costs remained constant between both regimes, the higher monetary gains achieved in FLD plots were entirely driven by superior productivity and marketability resulting from improved varieties and optimized crop management practices rather than additional operational expenses.

Gross and net monetary returns: Knol-khol registered the highest gross returns (Rs 3,75,000/ha) and net returns (Rs 2,97,000/ha) under FLDs, delivering

Table 3. Economic analysis and benefit-cost ratio of front line demonstrations (FLDs) versus farmers' practice in vegetable cultivation

Crop	Cost of cultivation (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		BCR	
	FLD	Farmers' practice	FLD	Farmers' practice	FLD	Farmers' practice	FLD	Farmers' practice
Knol-khol	78,000	78,000	3,75,000	2,70,000	2,97,000	1,92,000	3.8	2.4
Okra	70,000	70,000	2,72,000	1,77,200	2,02,000	1,07,200	2.9	1.53
Onion	84,000	84,000	3,66,000	3,02,400	2,82,000	2,18,400	3.4	2.6
Spinach	77,000	77,000	2,26,000	1,84,000	1,49,000	1,07,000	2.3	1.4
Radish	79,000	79,000	3,30,000	2,16,000	2,51,000	1,37,000	3.1	1.7

an additional net benefit of Rs 1,05,000 per ha over conventional farming (Rs 1,92,000/ha). Onion yielded Rs 2,82,000 per ha in net returns under FLDs compared to Rs 2,18,400 per ha under conventional practice, generating an additional profit of Rs 63,600 per ha. Radish generated Rs 2,51,000 per ha under FLDs versus Rs 1,37,000 per ha in local checks, securing the highest absolute increase in net returns among all crops at Rs 1,14,000 per ha.

Okra achieved Rs 2,02,000 per ha in net returns under FLDs compared to Rs 1,07,200 per ha under conventional cultivation, delivering an extra return of Rs 94,800 per ha. Spinach recorded net returns of Rs 1,49,000 per ha under FLDs against Rs 1,07,000 per ha in local checks, providing an incremental gain of Rs 42,000 per ha.

Benefit-cost ratio (BCR): Knol-khol achieved the highest BCR of 3.8 under FLD (vs 2.4 in conventional practice), highlighting its high commercial efficiency. Onion followed closely with a BCR of 3.4 under FLD (vs 2.6). Radish and okra registered substantial improvements in profitability, increasing from 1.7 to 3.1 and 1.53 to 2.9 respectively. Spinach demonstrated a BCR increase from 1.4 to 2.3.

The economic analysis confirmed that adopting recommended technological packages through FLDs significantly enhanced farm income and return on investment without elevating production expenses, proving highly advantageous for vegetable growers.

Balai et al (2013) reported enhanced economic returns across all three demonstration crops over a five-year period. Okra recorded the highest gross returns at Rs 1,75,313 per hectare (with an additional net return of Rs 48,316/ha over local checks), while brinjal achieved the highest net returns of Rs 1,24,928 per hectare. Onion recorded the highest benefit-cost ratio of 4.20 under improved practices, significantly outperforming its traditional check (2.99).

Balai et al (2014) reported that Krishi Vigyan Kendra introduced hybrid varieties and scientific management practices for chilli, bottlegourd and tomato via frontline demonstrations in Dungarpur district, Rajasthan. Across all three major vegetable crops, the improved technologies significantly enhanced productivity, gross returns, net returns and benefit-cost ratios compared to traditional farmers' practices.

Saravanakumar et al (2020) observed that adopting recommended production practices for black gram generated a net return of Rs 23,134.50 per hectare with a BCR of 2.03, outperforming traditional practices, which recorded a BCR of 1.65.

Singh and Dwivedi (2020) demonstrated superior economic returns across all evaluated vegetable crops. Under recommended management practices, maximum net incomes achieved were Rs 4,04,000 per hectare for tomato in 2017-18 (vs Rs 1,84,000/ha in farmer check plots), Rs 3,74,800 per hectare for cabbage in 2017-18 (vs Rs 2,96,800/ha in check plots) and Rs 3,77,000 per hectare for cauliflower in 2015-16 (vs Rs 2,33,000/ha in check plots). Furthermore, vegetable pea generated a peak net income of Rs 3,30,000 per hectare in 2016-17 (vs Rs 2,00,000/ha in check plots during 2015-16) and onion recorded its highest net return of Rs 3,94,500 per hectare in 2016-17 (vs Rs 2,11,400/ha in check plots).

Bharti et al (2024) demonstrated substantial economic benefits from adopting improved green gram production practices, securing an average net return of Rs 87,737 per hectare with a mean BCR of 4.78. In comparison, traditional farmers' practices yielded a lower average net return of Rs 65,061.60 per hectare, confirming the superior profitability and economic viability of the demonstrated package of practices.

Lodhi et al (2025) demonstrated that adopting recommended practices delivered higher net returns (up to Rs 1,46,500/ha) and achieved a superior BCR of 2.15-3.07 vs 1.80-2.82 for local practices in vegetable cowpea cultivation.

Farmer feedback and implications for research and extension

The frontline demonstrations clearly established that the recommended vegetable cultivars outperformed traditional local checks across Samba district.

Despite the region's undulating topography and diverse micro-climates, all demonstrated cultivars exhibited superior yield potential and economic viability. While overall crop performance was highly favourable, farmer feedback highlighted minor requirements for further breeding refinements. Specifically, targeted crop improvement is needed in a few cultivars to optimize key phenotypic traits and enhance tolerance to local pests and diseases under field conditions.

Singh et al (2013) reported a positive overall response from farmers toward intervened agricultural technologies in Ranchi district, Jharkhand. Farmers rated the assessed practices high in socio-cultural compatibility, farming system integration, simplicity, resource availability, low risk and visibility compared to traditional practices. Consequently, most farmers preferred refined technologies tailored to their specific agro-ecological and socio-economic conditions over rigid recommended packages.

CONCLUSION

Frontline demonstrations conducted by KVK Samba successfully demonstrated the field-level feasibility, economic superiority and yield advantages of improved vegetable cultivars over traditional farmers' practices in the Samba district of Jammu and Kashmir. Introducing high-yielding, stress-tolerant varieties such as Jammu Okra-05, G-40 (knol-khol), Bhima Red (onion), Jammu Spinach Beet-07 and Pusa Chetki addressed core productivity bottlenecks, delivering yield improvements of 22.0 to 53.4 per cent without raising production expenditures. Low technology indices across all evaluated crops (9.3 to 19.2%) highlight the high adaptability and technical viability of these production packages under local field conditions.

However, the substantial extension gaps observed, particularly in onion (55.0 q/ha), okra (47.4 q/ha) and knol-khol (45.0 q/ha), underscore an urgent need for strengthened extension mechanisms to bridge the gap between experimental yields and actual farm-level realizations. Broadening the reach of extension activities through systematic capacity-building programmes, field days and timely input supply will be vital to accelerating wider technology adoption. Additionally, addressing farmer feedback through targeted breeding refinements for specific phenotypic traits and disease resistance will further secure the long-term sustainability and economic resilience of smallholder vegetable growers in the region.

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